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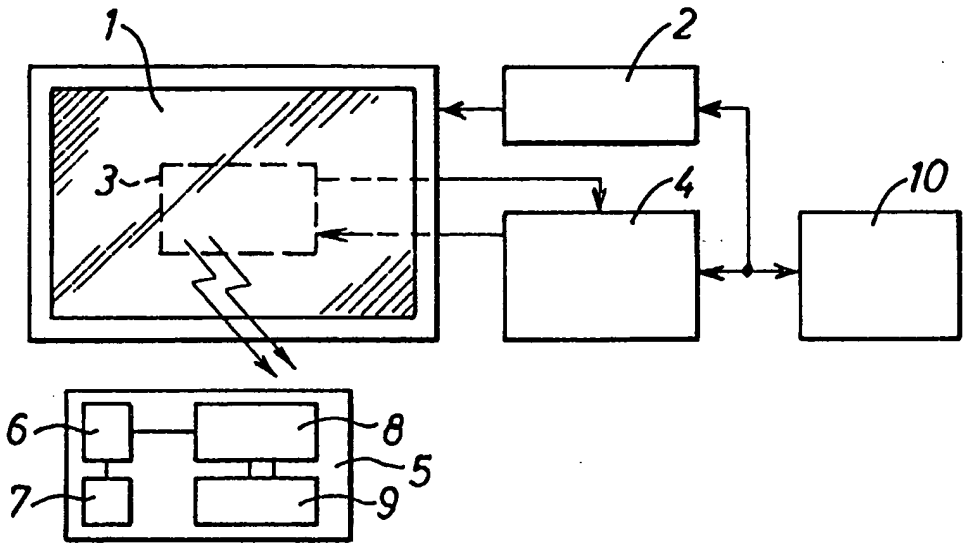
(54) Title: CONTACTLESS SMART CARD READER




(57) Abstract

A contactless smart card reader is formed by a visual display unit incorporating a display screen (1) and a smart card power and reading antenna (3) arranged to supply power to and read data from a contactless smart card (5) placed adjacent to the screen (1). Preferably the antenna (3) is formed behind the display screen (1) and the contactless smart card (5) is read through the display screen (1).

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# Contactless Smart Card Reader

This invention relates to a contactless smart card reader and in particular to such a unit arranged to read a smart card adjacent a display screen.

Further, this invention relates to a smart card communication system employing such a reader.

Contactless smart cards are portable devices containing an antenna and circuitry connected to the antenna, generally in the form of an integrated circuit physically embedded within the device. As the name suggests, smart cards are conveniently formed in the same size as other forms of credit card or swipe card but the term smart card is used generically to cover similar devices which may have a different size or shape including antenna's and integrated circuits embedded into other items such as keys or watches.

In general contactless smart cards have no on board power supply and store information in a non-volatile memory on an embedded chip. A contactless smart card read/write unit including an antenna which transmits an RF (radio frequency) electromagnetic field is used to communicate with the contactless smart card. When the contactless smart card is brought into close proximity to the antenna of the read/write unit the RF field generates an oscillating current in the smart card antenna.

Power management circuits on board the smart card convert this into power to operate the embedded chips or other circuitry on the smart card.

Data can then be transmitted from the read/write unit to the smart card by modulation of the transmitted RF field. Further, data can be transmitted back from the smart card to the read/write unit by circuitry within the smart card modulating the RF field. The read/write unit then detects these changes in the RF field to read the data being sent by the smart card.

The chief advantage of the contactless smart card is the absence of any requirement for electrical contact between the smart card and the read/write unit. This allows both the smart card and the read/write unit to be completely sealed against environmental damage and eliminates any risk of damage to or short circuiting between physical contacts.

In use, difficulties have been encountered with smart cards with ensuring that smart cards are placed close enough to the antenna of a read/write unit to allow reliable data transfer during operation. Although in theory a communication link between a smart card and a read/write unit can be sustained over distances of several meters, in practice the requirement for an RF field to power the smart card and allow two way data transfer imposes limitations, due primarily to the strength of RF field required.

In general, due to the widespread, and increasing, use of electronics in all spheres of technology the emission of potentially interfering RF fields is regarded as undesirable and where such fields are produced it is generally desirable to limit their strength and physical extent as far as possible.

In addition to the general requirement to reduce electromagnetic emissions to a minimum, it is also desirable for reason of security to minimise the strength of the emitted RF signal to make attempts at intercepting and recording the data transferred between the smart card and the read/write unit as difficult as possible.

Finally, where multiple smart cards and read/write units are present at the same location it is important to ensure that each read/write unit communicates only with a smart card which it is intended to communicate with and is not interfered with by another smart card, and vice versa, and this is generally best achieved by minimising the strength of the emitted RF field.

As a result, primarily for the above reasons but also on grounds of safety and minimising power consumption, although it is entirely possible to operate a contactless smart card read/write unit with a sufficiently powerful RF field that a smart card carried anywhere on a users body will always be able to maintain a communication link it is usually necessary or mandatory to operate with a low power RF field so that the user must place the smart card within a relatively small reading volume of space, for example a few tens of centimetres radius from the read/write antenna, in order to allow data transfer. This also provides the advantage that where the user is carrying more than one smart card only an intended smart card physically placed or held adjacent the read/write unit antenna will be in communication with the read/write unit. This will be particularly important as existing credit or debit swipe cards are replaced by smart cards

to provide a safeguard against charges being made to the wrong credit card account, for example.

Because of this requirement that smart cards be placed within a limited region around a read/write unit antenna to allow reliable communication and data transfer between the read/write unit and the smart card difficulties have been encountered in practice with users failing to place the card in the required proximity to the read/write antenna to allow communication. This is particularly a problem where the smart card must interact with the read/write unit with a series of operations being carried out by the user so that repeated communication over a period of time is necessary. In such applications it often occurs that the user initially places the smart card in position to allow communication to begin but then removes or puts away the smart card before all of the necessary communications have been carried out.

The present invention was made in an attempt to increase the reliability of contactless smart card communication and overcome the above problems.

In a first aspect this invention provides a contactless smart card reader comprising a visual display unit (VDU) incorporating a display screen and a smart card power and reading antenna arranged to allow power to be supplied to and data to be read from a contactless smart card located adjacent to the display screen.

In a second aspect this invention provides a contactless smart card communication system comprising a contactless smart card reader as set out above and a contactless smart card.

In a third aspect this invention provides a method of operating a contactless smart card reader as set out above in which the display screen displays a target region of screen over which the contactless smart card should be placed.

The contactless smart card reader, communication system or method or operating thereof according to the invention allows instructions to be given to the user regarding the need to place, retain or replace the contactless smart card adjacent a location on the display screen to ensure correct and timely location of the contactless smart card relative to the reader and so allow a reliable communications link to be maintained.

A contactless smart card reader employing the invention will now be described, by way of example only, with reference to the accompanying diagrammatic figures, in which:

Figure 1 shows a contactless smart card reader and cooperating contactless smart card, and

Figure 2 shows a display shown by the system of figure 1.

Referring to figure 1 the operation of a smart card read/write unit according to the invention is shown.

A visual display unit (VDU) screen 1 displays data provided by a display device 2 which may be a dedicated display processor or a general purpose computer such as a PC.

An antenna 3 is formed behind the screen 1 and is driven by read/write electronics 4.

In use, the read/write electronics 4 supply an RF signal to the antenna 3 to generate an RF field which is transmitted through the VDU screen 1.

A contactless smart card 5 for use with the read/write unit includes a tuned antenna 6 tuned to the frequency of the RF field emitted from the antenna 3. The tuned antenna 6 is connected to a power regulator 7, data modulator 8 and a processor 9 all sealed within the smart card 5.

When a user brings the smart card 5 close to the antenna 3 the RF field will generate induced oscillating currents in the tuned antenna 6. The power regulator 7 converts the oscillating induced currents in the tuned antenna 6 into a DC power supply which is used to power the processor 9 and other electronic components, such as a memory, on the smart card 5. There may be a separate memory or a memory may be included on the same chip as the processor 9, as is convenient.

Once the contactless smart card 5 is powered up data transfer between the read/write unit and the smart card 5 can be carried out.

In order to read data from the smart card 5, data held in a non-volatile memory such as an eeprom or flash memory is placed in a suitable form for transmission by the processor 9 and then passed to the data modulator 8. The data modulator 8 alters the impedance of the tuned antenna 6 to modulate the RF field strength re-received by the

antenna 3 according to the read data. The read/write electronics 4 detects this modulated change in the RF field strength at the antenna 3 and processes this to obtain the read data. The read data is then transferred to a data processing unit 10 for processing.

In order to write data to the smart card 5, data is sent from the data processing unit 10 to the read/write electronics 4. The read/write electronics 4 modulate the signal supplied to the antenna 3 to modulate the RF field. The modulated RF field is received by the tuned antenna 6 and modulates the oscillating currents generated within the tuned antenna 6. The modulated currents are detected by the data modulator/demodulator 8 and supplied to the processor 9. The processor 9 then operates according to the data received, which can be data to be placed in the non-volatile memory, program instructions to be followed by the processor, encryption information or any other desired data.

In addition to supplying data to the read/write electronics 4 for transmission to the smart card 5, the data processing unit 10 also supplies information to the display data generator 2 to control the data shown on the display screen 1. This allows messages to be displayed on the screen 1 relating to use of the smart card 5. For example, the region overlying the antenna 3 can be indicated as the location over which the smart card 5 should be placed. Further, if a user is attempting to carry out an activity requiring the reading of data from the smart card and such data reading from the smart card 5 cannot be carried out a message can be displayed on the screen 1 requesting that the smart card 5 be placed in close proximity to or against the screen 1 at the location overlying the antenna 3. Similarly, where a series of data read and write operations between the unit and the smart card 5 must be carried out over a period of time and the communication link between the unit and the smart card is lost during the operation, the screen 1 can display a message instructing the user to replace the smart card 5 close to or against the screen 1 in the indicated region over the antenna 3.

In Figure 1 the antenna 3 is shown as being located behind and in the centre of the display screen. There are a number of different arrangements for forming the antenna adjacent to the display screen as part of a visual display unit (VDU). One possibility with any type of VDU is to form the antenna by thin wires secured or printed

on the front face of the display or, more securely, where there are multiple layers to the display on a surface not exposed to physical contact by a user. Alternatively, but generally less conveniently, the antenna can be formed by wires embedded within a screen surface.

In another alternative, the antenna can be formed by wires located around the periphery of the screen.

All of the above options are suitable for use with any form of visual display unit, including liquid crystal displays (LCD), a thin film transistor (TFT) screen, light emitting diode array (LED's), plasma, gas discharge, SDNA or cathode ray tube (CRT) displays.

Preferably, the antenna can be mounted behind the screen to operate through it. This can conveniently be carried out by integrating the antenna into a PCB of the read/write electronics 4 or the driver electronics for the display 1 located behind the screen. However, the use of an antenna mounted behind the display screen and operating through it will not normally be convenient in a cathode ray tube display due to the physical size and depth of the CRT screen and the conductive layers within a CRT display, which will tend to block the RF field.

In display units having a conductive or circuit carrying layer as an integral part of the screen structure the antenna can conveniently be formed as a part of this conductive layer.

In general visual display units operate at a relatively low image refresh rate of around 50hz or so, a frequency arrived at as being above the minimum frequency required to provide a stable non-flickering image based on the image persistence characteristics of the human eye and technically convenient for historical reasons as allowing CRT type displays to be driven with a frame rate similar to the frequency of mains AC supplies.

In contrast, smart cards usually use frequencies in the range 100 to 150 Khz (designated as low frequency) or 13.56 Mhz (designated high frequency).

As can been seen, the operating frequency for the RF driving and data carrying field of the contactless smart card 5 will generally be orders of magnitude different from the refresh rate, and thus control signal frequency, of the display screen 1. As a result, it

is generally simple to arrange for the RF driving field from the antenna 3 to pass through the display screen 1 without impairing the operation of the display screen or the contactless smart card read/write system. The main requirement is that it is possible to project the RF driving field from the antenna 3 through the display screen 1 if the antenna 3 is to be placed behind the display screen 1. If this is a problem, for example in a CRT display, the use of an antenna surrounding the display screen or formed in or on a front face of a display screen may be necessary.

The antenna 5 operates independently from the screen 1 so that the antenna can power and read a contactless smart card even when the screen is switched off. This allows the screen to be powered up from a stand by condition when the presence of contactless smart card is detected.

Referring to figure 2, a touch sensitive LCD display screen for carrying out ATM operations (automatic bank teller operations) is shown.

The display screen 11 has a contactless smart card power/read/write antenna 12 located behind the centre of the screen 11 and a touch sensitive region of the screen 11a is located directly over the antenna 12.

Five further touch sensitive regions of screen 11b to 11f are situated in a vertical line along the left hand side of the screen 11 while a further group of five sensitive regions 11g to 11k are arranged in a vertical line down the right hand side of the display screen 11.

When the automatic teller unit is on standby the message "place card here" is displayed on the screen 11 in the central region corresponding to the touch sensitive region 11a overlying the antenna 12 together with a card target outline surrounding this region and arrows pointing towards the target outline.

When a contactless smart card is moved adjacent to the screen 11 overlying the antenna 12, the presence of the smart card is detected from changes in the RF signal received by the antenna 12 and the reading of data from the smart card to identify the user and account details commences.

Once the required data has been read from the smart card a message will be displayed on the screen 11 requesting that the user enter a personal identification

number (pin) and the touch sensitive pads 11b to 11k will be identified on the screen as numerical keys.

The number of touch sensitive regions provided can of course be varied as desired.

The user can then input the pin number using the contact sensitive areas 11b to 11k and the pin number can be compared with data carried on or derived from the smart card to authorise proceeding with the transaction in any one of the ways already known for use in ATM systems.

If the pin number is correct message regarding the desired transactions are displayed and commands are entered through the touch-sensitive areas 11b to 11k, as if well known.

If the pin number is incorrect a message to this effect will be displayed on the screen 11 and the user will be invited to re-enter their pin number or informed that due to repeated failure to correctly provide a pin number use of the card is being suspended, in a similar manner to known ATM systems.

Where the presence of a contactless smart card is detected but the data read from the card is not identified as a card suitable for use with the ATM system or data cannot be read from the card or there is contact with one of the contact sensitive areas 11a to 11k without the presence of a contactless smart card being detected, the screen 11 displays the message "invalid card type?" or "card unreadable" as appropriate.

During the ATM operation it may be necessary to write data to the smart card, for example identifying the number of incorrect pin number entries made, providing updating information to maintain encryption security or changing data held on the card regarding available credit. If this data writing cannot be carried out because of loss of the communication to the smart card, a message requesting the user to replace the card in the central region of the screen 11 overlying the antenna 12 can be re-shown together with the target outline and arrows. If the smart card is not then detected the transaction is aborted and a message to this effect displayed. However, if after requesting that the user replace the smart card no smart card is detected but there is contact with the central contact sensitive region 11a of the screen 11 the operation is aborted and a message indicating a possible card fault is displayed.

It will be understood that the data transfer between the smart card and the ATM machine card reader may be encrypted for security.

The use of a contact sensitive display having the antenna located behind and within the display is regarded as a particularly advantageous combination because it allows for communication between the smart card and the read/write unit, manual input of pin number or other data and display of operating instructions or other data to the user with the minimum physical size and a minimum number of parts exposed to the outside environment and possible vandalism. However, the display screen incorporating an antenna and having an associated key pad or buttons in addition to or instead or touch sensitive regions of the screen could be used to input user data.

Although the specific example described is an ATM machine, a combined reader and display unit according to the invention can be used in any smart card application. Typical smart card applications in which the invention can be used include, but are not limited to, gaming machines, pre-payment service or utility provision, historical data storage, point of sale transactions, loyalty schemes, authorisation and access schemes (for example pay per view television), manufacturing machine control, personal computer access and remote computer access over the Internet.

Normally, the region within which the smart card can sustain communications with the read/write unit will extend several tens of centimetres from the display screen so that even when the user places the smart card against the central region of the screen and then removes it immediately there will be sufficient time for communication with card as it approaches and moves away from the screen for the necessary data reading and writing operations to be carried out. However, where multiple data reading or writing operations must be carried out or where electromagnetic emissions are to be reduced to the absolute minimum it could be necessary to have a communication region extending only a few centimetres from the display screen surface so that a user must hold the smart card adjacent to or against the display screen for several seconds. In this case, the screen could initially display a message requesting that the card be placed in a target region overlying the antenna and then display messages requesting that the card be held in place and then indicating that the card can be removed.

The message displayed when the ATM system shown in Figure 2 is on standby could be displayed by operating the screen 11. Alternatively, the message could be permanently displayed by being printed on the face of the screen 11 and the screen 11 powered down when the system is on standby. The screen 11 could then be powered up when the antenna 12 detects the presence of a contactless smart card.

The above embodiments are examples only and it will be understood by the person skilled in the art that other arrangements could be used.

**Claims:**

1. A contactless smart card reader comprising a visual display unit incorporating a display screen and a smart card power and reading antenna arranged to allow power to be supplied to and data to be read from a contactless smart card located adjacent to the display screen.

2. A reader as claimed in claim 1, in which the antenna is a smart card power, reading and writing antenna arranged for allow power to be supplied to and data to be read from or written to a contactless smart card located adjacent to the visual display unit.

3. A reader as claimed in claim 1 or claim 2, in which the antenna is formed behind the display screen.

4. A reader as claimed in claim 3, in which the antenna is arranged to produce an electromagnetic field passing through the display screen.

5. A reader as claimed in claim 4, in which the antenna reads the contactless smart card through the display screen.

6. A reader as claimed in any preceding claim, in which the display screen is a liquid crystal display.

7. A reader as claimed in any preceding claim, in which the display screen is touch sensitive.

8. A contactless smart card communication system comprising a contactless smart card reader according to any preceding claim and a contactless smart card.

9. A method of operating a contactless smart card reader according to any one of claims 1 to 7, in which the display screen displays a target region of screen over which a contactless smart card should be placed.

10. A method of operating according to claim 9, in which the antenna is formed behind the display screen and the target region corresponds to the antenna position.

11. A contactless smart cart reader substantially as shown in or as described with reference to either of the accompanying figures.

12. A contactless smart card communication system substantially as shown in or described with reference to either of the accompanying figures.

FIG. 1

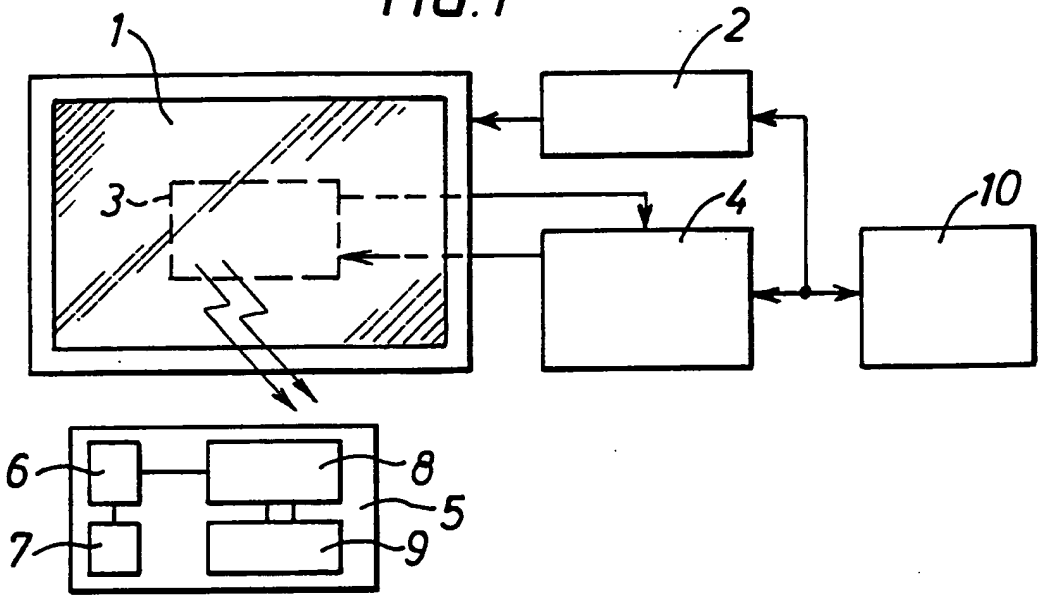
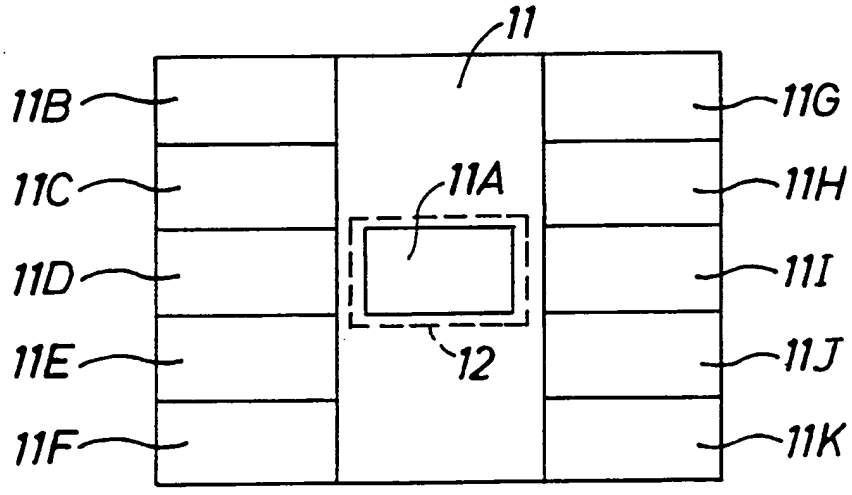



FIG. 2



# INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/GB 00/01064

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K7/00 G06K7/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>A | EP 0 810 540 A (MOTOROLA INC)<br>3 December 1997 (1997-12-03)<br>column 3, line 6-47; figure 1<br>--- | 1,2<br>3-7 |
| P,X | EP 0 977 159 A (HITACHI COMPUTER PRODUCTS EURO) 2 February 2000 (2000-02-02)<br>column 2, line 19-53; figures 1,2<br>--- | 1-7 |
| P,X | EP 0 919 945 A (MATSUSHITA ELECTRIC IND CO LTD) 2 June 1999 (1999-06-02)<br>column 3, line 31-44<br>column 7, line 43 -column 8, line 17;<br>figures 1,2,5,6,8<br>--- | 1-5,8,9 |
| A | GB 2 291 726 A (HALPERN JOHN WOLFGANG)<br>31 January 1996 (1996-01-31)<br>claim 1; figure 1<br>--- | 1-5 |
| | -/-- | |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 20 June 2000 | 06 JULY 2000 [see cover Page] |

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Form PCT/ISA/210 (second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
PCT/GB 00/01064

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | GB 2 252 188 A (HERBERT & SONS LTD)<br>29 July 1992 (1992-07-29)<br>page 3, line 22-28; claim 1; figures 1,6<br>--- | 1,2 |
| A | DE 42 05 615 A (PROVERA GES FUER PROJEKTIERUNG) 26 August 1993 (1993-08-26)<br>column 2, line 18-40; figures 1,2<br>----- | 1,2,8,9 |

# INTERNATIONAL SEARCH REPORT

Ii. national application No.
PCT/GB 00/01064

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:.

2. ☒ Claims Nos.: 11,12
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 11,12

Present claims 11 and 12 relate to an apparatus defined by reference to the drawings contained in the application.

Claims 11 and 12 do not define any technical feature of the claimed contactless smart card reader. An attempt is made to define the subjet matter for which protection is sought only by reference to the accompagnying drawings. Therefore claims 11 and 12 lack clarity (Article 6 PCT). This lack of clarity is such as to render a meaningful search impossible. Consequently, the search has not been carried out for these claims.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

# INTERNATIONAL SEARCH REPORT

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